REMARKS

The Application has been carefully reviewed in light of the Office Action dated June 19, 2003 (Paper No. 18). Claims 1 to 5, 13 to 15, 30, 33 and 35 are pending in the application, of which Claims 1, 13, 30, 33 and 35 are the independent claims. Claims 1, 13, 30, 33 ad 35 have been amended herein. Reconsideration and further examination are respectfully requested.

By the Office Action, Claims 1 to 5, 13 to 15, 30 and 33 have been rejected under 35 U.S.C. § 103(a) over JP 11-23324 (Igaki '324), U.S. Patent 5,124,548 (Igaki '548) and U.S. Patent 3,856,401 (Heitmann), and Claim 35 is rejected under 35 U.S.C. § 103(a) over Igaki '324, Igaki '548 and U.S. Patent 5,498870 (Ishizuka). Reconsideration and withdrawal of the rejection are respectfully requested.

Claims 1 to 5 and 30

The present invention generally concerns an optical encoder which includes a light irradiating system, four light-receiving elements disposed essentially in a line and an optical system. The optical system includes a dividing element that divides the light from the light irradiating system into beams so as to guide the beams to their respective light-receiving elements. To divide the light into beams, the dividing element has a plurality of V-grooves, each of which has two planes of mutually different slope angles juxtaposed at a predetermined pitch. The four beams formed from the dividing element have different phases arranged for reception by the four light-receiving elements.

By virtue of this arrangement, it is possible to obtain a stable signal despite light intensity variations or noise.

Turning to the specific language of the claims, Claim 1 defines an optical encoder comprising a light irradiating system, an optical scale having a grating for transmitting or reflecting incident light, four light-receiving elements disposed essentially in a line; and an optical system. The optical system is constructed so as to amplitude-modulate light traveling from the light irradiating system to the optical scale and transmitted or reflected by the grating, by a dividing element in which a plurality of V-shaped grooves are juxtaposed, and so as to divide the amplitude-modulated light into beams along a plurality of different directions to guide the beams to the respective light-receiving elements. The dividing element is comprised of repetitions of such structure that a plurality of V-grooves, each of which has two planes of mutually different slope angles, the V-grooves are juxtaposed at a predetermined pitch to form four beams having different phases arranged for reception by the four light receiving elements.

The applied art, namely Igaki '324, Igaki '548, and Heitmann, is not seen to disclose or to suggest the features the claim, particularly with respect to four light-receiving elements disposed essentially in a line and a dividing element comprised of repetitions of a structure such that a plurality of V-grooves, each of which having planes of mutually different slope angles, are juxtaposed at a predetermined pitch to form beams having different phases arranged for reception by the four light-receiving elements.

It is conceded in the Office Action that Igaki '324 fails to disclose V-grooves each having two planes of mutually different slope angles, and that Igaki '324 fails to disclose four beams. It is indicated in the Office Action that Igaki '548 discloses the use of such V-grooves, and that Heitman discloses the use of four beams. For the following reasons, Applicants submit that none of the applied references teach or suggest these

features.

More particularly, Igaki '548 is not seen to describe a V-groove with two planes of mutually different slope angles. The discussion at col. 4, lines 46 to 52 of Igaki '548 is seen to indicate that an angle formed by the planes of a V-groove need not be 45°. In other words, the cited portion of Igaki '548 is seen to indicate that the angle formed by the planes of each V-groove need not be 45°, and could be 50°, for example. However, this is not seen to be the same as the claimed feature wherein one plane of a V-groove has a different slope angle than the other plane of the V-groove.

Heitmann has been reviewed and is not seen to disclose the feature that the planes of a V-groove have different slope angles. In addition, neither Heitmann nor Igaki '548 is seen to teach or to suggest forming four beams arranged for reception by four light-receiving elements disposed essentially in a line.

The Office Action cites Figures 2 and 2a of Heitmann has showing four beams. However, Figures 2 and 2a of Heitmann are seen to depict receivers 28 to 31 arranged in a manner, which is other than a line. Accordingly, Heitmann is not seen to disclose or to suggest forming four beams arranged for reception by four light-receiving elements disposed essentially in a line.

In view of the above, the cited art is not seen to disclose or to suggest the features of Claim 1. Accordingly and for at least the foregoing reasons, Claim 1 is believed to be allowable over the cited art. In addition, Claim 30 is believed to be allowable for at least the same reasons.

Claims 13 to 15 and 33

The present invention generally concerns an optical encoder having a light irradiating system, an optical scale, a light-receiving element and an optical system. The optical scale has first and second regions, each of which has scale slits comprised of grooves of a V-shaped cross section, and the optical system makes light traveling from the light irradiating system to the scale slits of the first region of the optical scale incident to the scale slits of the optical scale's second region so as to guide the light to the light-receiving element. The slope angles of the V-shaped cross section in the first region of the optical scale are different from the slope angles of the V-shaped cross section in the second region in the optical scale, and the slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in the first and second regions.

By virtue of this arrangement, it is possible to obtain a stable signal despite light intensity variations or noise.

Turning to the specific language of the claims, Claim 13 defines an optical encoder comprising a light irradiating system, an optical scale comprising scale slits of a periodic structure, a light-receiving element; and an optical system constructed so as to make light traveling from the light irradiating system to the scale slits of a first region of the optical scale, incident to the scale slits of a second region of the optical scale by a mirror or another optical element to guide the light having passed via the scale slits of the second region to the light-receiving element. The optical scale the scale slits of the first and second regions are comprised of grooves of V-shaped cross section and slope angles of the V-shaped cross section in the first region are different from slope angles of the V-shaped cross section in the second region, and wherein slope angles are different from each

other between the grooves of the V-shaped cross section of the scale slits in the first and second regions to form four beams having different phases.

Neither Igaki '324 nor Igaki '548, either alone or in any permissible combination, is seen to teach or to suggest the feature of the slope angles of the V-shaped cross section in the first region being different from the slope angles of the V-shaped cross section in the second region, and/or the feature of the slope angles being different from each other between the grooves of the V-shaped cross section of scale slits in the first and second regions so as to form four beams having different phases.

It is conceded in the Office Action that Igaki '324 fails to disclose these features. As discussed above, Igaki '548 is seen to describe using an angle other than 45° as the uniform angle for its V-grooves. Thus use of a uniform angle which need not be 45° is not understood to teach or to suggest slope angles of the V-shaped cross section in the first region being different from the slope angles of the V-shaped cross section in the second region, and/or slope angles being different from each other between the grooves of the V-shaped cross section of scale slits in the first and second regions.

For at least the foregoing reasons, Claim 13 is believed to be in allowable condition. In addition, Claim 33 is believed to be allowable for at least the same reasons.

Claim 35

The present invention generally relates to a driving system having an optical encoder, which includes an optical system constructed so that light reflected by a first region of an optical scale is condensed via only one condensing mirror onto scale slits of a second region of the optical scale so that the light having passed via the second region's

scale slits is guided to a light-receiving element of the optical encoder. An important feature is that the first and second regions are adjacently positioned along a radial direction.

Turning to the specific claim language, Claim 35 defines a driving system comprising a driver system, a control system for controlling driving of the driver system, and an optical encoder for detecting information on the driving of the driver system to output a signal to the control system. The optical encoder comprises a light irradiating system, an optical scale comprising scale slits of a periodic structure, a light-receiving element, and an optical system constructed so that light traveling from the light irradiating system to the scale slits of a first region of the optical scale and reflected by the first region is reflected and condensed via only one condensing mirror onto the scale slits of a second region of the optical scale and so that the light having passed via the scale slits of the second region is guided to the light-receiving element. The optical scale's first and second regions are adjacently positioned along a radial direction.

It is conceded in the Office Action that neither Igaki '324 nor Igaki '548 discloses light traveling from a light irradiating system to scale slits of a first region of an optical scale being reflected by the first region onto the scale slits of a second region of the optical scale. Accordingly, Applicants submit that Igaki '324 and Igaki '548 fail to disclose that the first and second regions are adjacently positioned along a radial direction. Applicants further submit that Heitmann is not understood to disclose this feature.

Figure 1 of Heitmann, which is cited in the Office Action, is seen to describe reflecting light between gratings positioned above and below each other, which is not seen to be the same as first and second regions adjacently positioned along a radial direction.

Accordingly and for at least the foregoing reasons, Claim 35 is believed to be in allowable condition.

CONCLUSION

The remaining claims are each dependent from the independent claims discussed above and are therefore believed patentable for the same reasons. Because each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration of each on its own merits is respectfully requested.

In view of the foregoing, the entire application is believed to be in condition for allowance, and such action is respectfully requested at the Examiner's earliest convenience.

Applicants' undersigned attorney may be reached in our Costa Mesa, California office at (714) 540-8700. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,

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